Application of ABC and XYZ Analysis to Inventory Optimization at a Commercial Enterprise

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Abstract. Inventory management at an enterprise is the essential logistics function. Reducing inventory maintenance costs and optimizing the range of goods while focusing on consumer demand analy-sis are inextricably linked to inventory management methods. This article describes the differentiated inventory management model of the ABC-XYZ classification matrix in relation to the inven-tory of Karandash LLC commercial enterprise (Tomsk). Inventory management is a highly relevant issue, since the company has several branches, cooperates with many suppliers, and its range of office supplies includes more than 30 000 items. The ABC-XYZ-analysis of the inventory of this commercial enterprise allowed us to determine strategies for optimizing inventory and to identify the groups that should be removed from the range, and, vice versa, should be available in stock due to constant demand.

1 Introduction

Due to increased competition among commercial enterprises, the main ad-vantage is competent inventory management. Inventory is the key aspect of contin-uous operation of any enterprise.

In modern market conditions, production and commercial companies face an increase in the product classification and the range at warehouses of various levels [1]. ABC and XYZ analysis are the methods used for systematization and multi-product inventory grouping described in detail in professional literature [2]. The result of ABC analysis is a grouping of objects by the degree of impact on the overall result.

When managing inventory, it is necessary to take into account the nature of inventory consumption [3], as well as the accuracy of forecasting changes in the demand [4]. The key

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difference between the XYZ method and the ABC method is the analysis of the quantitative indicators, which are usually presented as a time se-ries (series of values) q for each ith item of the inventory list.

The use of XYZ analysis allows one to predict the demand for a particular product. «XYZ analysis provides for the division of inventory into three groups de-pending on the uniformity of demand and the accuracy of forecasting» [5].

The division into the XYZ groups is based on the calculation of the coeffi-cient of variation V, which determines the proportion of deviations in demand rela-tive to the average volume of demand.

The coefficient of variation can be calculated using the following formulas [5]:

$$V = 100 \sigma_q / \bar{q}, \qquad (1)$$

where   V stands for coefficient of variation

σ_q stands for mean square deviation

$\bar{q}$ stands for mean value of the time series

$$\bar{q} = \sum_{i=1}^{N} q_i / N, \qquad (2)$$

$$\sigma_q = \sqrt{\frac{\sum_{i=1}^{N} (q_i - \bar{q})^2}{N}}, \qquad (3)$$

Where N stands for the number of periods of study

The distribution of the product range to X, Y and Z groups boils down to comparing the coefficient of variation calculated by the formula with the normative values that define the boundaries of the groups. For example:

- Group X includes the objects with a coefficient of variation not exceeding 10-15%;
- Group Y includes the objects with a coefficient of variation of 15-25%;
- Group Z includes the objects with a coefficient of variation greater than 25%.

However, in the professional literature [6], the standard values of X, Y and Z groups differ significantly. Obviously, in this situation, it is difficult to talk about a standard procedure for dividing into XYZ groups.

As a result of combining ABC and XYZ analysis, we have nine groups of objects according to two criteria that allow one to evaluate the degree of impact on the final result (ABC) and the stability (predictability) of this result (XYZ) [6, 7].

The inventory list of Karandash LLC, the office supplies retailer, consists of about 30 000 items. Therefore, the issue of applying the inventory management model is especially acute.

2 Research methods and data

For further calculations, we will identify the product group that has the most significant share in the turnover, apply ABC and XYZ analysis to it and calculate all the initial data for using the selected model in practice.

We have analyzed the data on the sales volume for each product group to select the most significant one and found that the largest share in the sales volume accounted for the Office

Paper product group with a substantial advantage. Its share in the annual turnover of the company was 19.42%.

We have applied ABC and XYZ analysis to this group to identify the invento-ry management model. The ABC analysis was performed separately for each item of the inventory. The main indicator for the analysis was the annual sales volume in rubles. The initial data were ranked in descending order. According to the classic dis-tribution of ABC groups (80/15/5), Group A includes the first three items of our in-ventory list, but the difference in indicators between the second and third items is very significant, 33.18% and 6.33%, respectively. In this case, only two clearly lead-ing items of the inventory list were allocated to Group A, amounting to 73.81% of the turnover. The next five items fell into Group B with 21.93%. In total, Groups A and B made up 95.74%. The remaining items were allocated to Group C with 4.26% (Table 1).

Table 1. Dependence of sales volume on the number of items in the range.

Group of products	Sum total, rub.	Total, %	Total number of items	Total, %
A	4825708.10	73.81	2	4.65
B	1433552.97	21.93	7	16.28
C	278478.26	4.26	34	79.07
	6537739.33	100	43	100

Conceivably, the number of inventory items in groups according to the ABC distribution is correlated as 20/30/50, but, in our case, it turned out to be 5/16/79. Thus, we can conclude that the product range is unbalanced. The studied product group contains too many items. The maximum amount of profit (96%) is generated by 9 items of the range, while the remaining 34 account for only 4% of the turnover. In order to assess the uniformity of demand for each item, the XYZ analysis was performed. In our case, to get more reliable results, we were considering the annual turnover broken down by month, i.e. twelve periods were analyzed. It should be not-ed that it was decided to perform XYZ analysis only for those items that had been available for sale for at least 6 months, and to exclude the items unavailable for sale, as well as those that had been in little demand for a long time. As a result, we selected 22 items for XYZ analysis and calculated the coefficient of variation for them. We consider the calculation of the coefficient of variation on the example of Paper No.7.

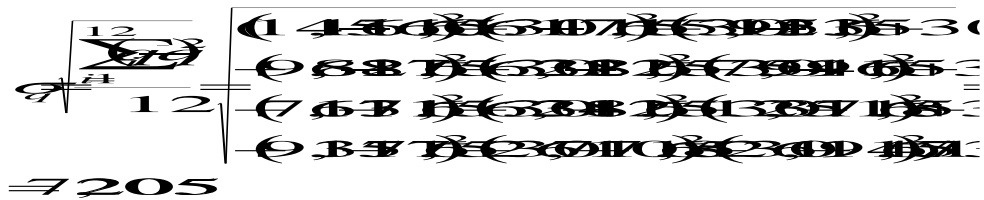1. Calculation ofthe average value of the dynamic series using the formula (2)
   This product had been in stock for 12 months, so the number of periods is N = 12

$$\bar{q} = \sum_{i=1}^{12} q_i / 12$$

$$\bar{q} = \left(\begin{matrix} 14560{,}16 + 6171 + 5123{,}95 + 9687{,}82 + 6222{,}38 + 7996{,}54 + 7631{,}17 + 6242{,}38 \\ + 12518{,}37 + 9157{,}78 + 26108{,}77 + 26947{,}10 \end{matrix} \right) / 12$$

$$\bar{q} = 11530$$

2. Calculation of the mean square deviation using the formula (3)

$$\sigma = \sqrt{\frac{1}{12}\sum_{i=1}^{12} (q_i - \bar{q})^2} = 7205$$

The coefficient of variation (1) equals to the following:
$$V = 100\,\sigma / \bar{q} = 100 * 7205,205 / 11530,6 = 62,49$$

Similarly, the coefficient of variation for each item was calculated (Table 2).

Table 2. XYZ-distribution of the items of the Office Paper group.

Name	Mean value of time series $\bar{q}$	Mean square deviation σ_q	Coefficient of variation V
Paper No.7	11530.62	7205.21	62.49
Paper No.14	99.24	89.02	89.70
Paper No.45	748.43	753.45	100.67
Paper No.32	34512.08	35115.03	101.75
Paper No.22	221364.04	226607.48	102.37
Paper No.43	248.22	255.04	102.75
Paper No.3	7377.29	7762.06	105.22
Paper No.20	17011.80	18070.50	106.22
Paper No.25	2758.75	3016.38	109.34
Paper No.46	33080.30	37639.65	113.78
Paper No.34	497.26	567.31	114.09
Paper No.17	752.28	881.71	117.21

3 Research results

The data obtained as a result of the analysis allow us to conclude that the demand for the items is not stable, i.e. fluctuates greatly over time. In such conditions, high or medium forecasting accuracy is impossible [6, 8]. Ultimately, the demand for items with coefficients of variation amounting to 62.49% and 89.7% can be, respectively, assumed with a higher probability than for the items at the end of the table, with an indicator of 244.98%. However, the entire list can be attributed only to Group Z. In this case, there will be no product items in Groups X and Y [9, 10]. Based on the obtained data, it is possible to choose an inventory management model for each of the groups: AZ, BZ, CZ (Table 3).

Table 3. Inventory management strategies based on the results of ABC-XYZ analysis.

Group	Range items	Inventory management strategy
AZ	Paper No.22, No.26	This group has a large contribution to the financial results, and the forecast is not very reliable due to the volatility of demand. The store should keep this group of products, but also further research the demand and possibly conduct appropriate promotions to attract customers to this type of product.
BZ	Paper No.3, No.7, No.20,	This group has a medium contribution to the financial results, and the forecast is not very reliable due to the

	No.24, No.32, No.46	volatility of de-mand. This group may be supplied on order and not stored at the warehouse.
CZ	Paper No.1, No.2, No.6, No.12, No.14, No.17, No.21, No.25	This group has a low contribution to financial results, a low forecast reliability due to the volatility of demand; if the compa-ny does not have enough funds, it can be removed from the range, but it is possible to stimulate sales at the expense of some products of this group by launching a promotion.

4 Conclusions

Applying these recommendations in practice allowed the company to significantly reduce inventory storage costs (by 20%), optimize the storage area, and improve the range, focusing on the rise of the items that are in stable demand.

When performing ABC and XYZ analysis, it is reasonable to exclude items that have been on sale for less than three months. ABC analysis showed that the product range of the Office Paper group is unbalanced. The maximum amount of profit is generated by 9 range items, the remaining 34 account for only 4% of turnover, and they can be excluded from the range in future. The volatility of demand and the inability to predict it (based on the results of XYZ analysis) provide for the decision to exclude or reduce the majority of items from the range list of the Office Paper group that fall into the BZ and CZ Groups. It should be noted that ABC-XYZ analysis allows the company to make sound decisions related tothe inventory management.

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